SESSION 1: Digital Practice Planning/DICOM Structured Reporting

Digital Radiology Equipment Acquisition and Installation Procedures: A Team Approach at Mayo Clinic, Rochester, MN

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Digital imaging system integration is a complex process. A project team and a defined process for system planning, evaluation, and implementation can improve the chance for success. In this presentation, our project team relates their experiences.

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A FEW YEARS AGO, radiology equipment acquisition and installation were simple: (1) purchase the equipment; (2) have vendor install it, (3) conduct acceptance testing, and (4) perform patient examinations.

Our department recently experienced digital imaging equipment installation culture shock and technostress. We selected computed radiography (CR) chest vendor components in the same manner as usual for conventional radiographic equipment and set up delivery dates. The installation and acceptance testing should have taken 2 weeks, but due to lack of planning for digital system integration, the process lasted 4 months.

We encountered communication problems within the system: for example, our Radiology Information System (RIS) did not talk to the acquisition equipment and allow the Digital Imaging and Communications in Medicine (DICOM) worklist to function, the laser printer did not receive images to print, and images would not transfer to the picture archive communication (PAC) system.

DISCUSSION

We resolved to improve our process for the next digital equipment purchase and proceeded to plan our new procedures. A multifunctional group was assembled to review issues and formulate a reasonable plan of action. Table 1 outlines our "project team" and function of each member.

In the initial meetings, the project team discussed the components, connectivity, and functions of a digital imaging system. The group quickly realized the interdependency of each member within the team. Important observations made

regarding the overall digital equipment evaluation to installation process were as follows:

- *The need to collect more than just the DICOM conformance statement information from the vendor.* The document "Imaging Modality Connectivity and Interoperability Requirements Worksheet" (IMCIRW) was developed and is now given to the vendor very early in the equipment evaluation process. Examples of questions from this multiple page document are shown in Fig 1.
- *The need to be proactive with system evaluation and integration.* During the CR chest unit installation we made unverified assumptions about component interactions and also assumed the multiple vendors were responsible to integrate their components with each other. We learned there are no dumb questions and we now plan site visits or clinical trials for thorough system evaluation.
- *The need for a project team to manage the process and a point person within the team to act as the communications contact.* During the CR chest unit installation several people talked to the vendors, resulting in a variety of confusing messages being relayed to the group. We wasted time sorting out messages and circulating pertinent information to the appropriate people.

Following a series of group meetings and input from all of our equipment purchasing parties (supervisors, directors, engineering, etc), an optimal

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Table 1. Digital Imaging Acquisition Equipment Project Team

Team Member	Function
Medical Physicist	<ol style="list-style-type: none"> 1. Provides theoretical level expertise in equipment specifications and functionality 2. Utilizes modality connectivity knowledge 3. Manages vendor negotiation and creates purchase agreements 4. Manages regulatory compliance issues
Medical Imaging Technical Services (MITS)	<ol style="list-style-type: none"> 1. Provides applications level expertise in equipment specifications and functionality 2. Performs equipment acceptance testing 3. Provides an applications perspective to workflow analysis
Imaging Equipment Services (Bioengineering)	<ol style="list-style-type: none"> 1. Coordinates installation with vendor 2. Provides support and service information 3. Advises team on needs for installation
Information Services (IS) Analyst Programmers	<ol style="list-style-type: none"> 1. Provides RIS functionality and connectivity expertise 2. Analyzes modality and PACS connectivity needs 3. Provides interface analysis and development as needed
Radiology Director	<ol style="list-style-type: none"> 1. Interfaces with vendor for quotes and price negotiation 2. Serves as the initial team facilitator until a point person is identified
Radiology Supervisor	<ol style="list-style-type: none"> 1. Provides a user perspective to workflow and facility design 2. Provides end user equipment functionality expertise
Radiologist	<ol style="list-style-type: none"> 1. Advises group and vendor regarding image quality needs 2. Provides committee approval support
Radiology Systems Coordinator (RSC)	<ol style="list-style-type: none"> 1. Provides a systems perspective to the workflow analysis 2. Coordinates RIS to modality and image display interactions
Facilities Project Services	<ol style="list-style-type: none"> 1. Analyzes and provides electrical and remodeling needs 2. Coordinates any remodeling or construction 3. Provides floor plans and facility information to vendor 4. Works with Imaging Equipment Services to provide required facility elements

Table 2. Digital Imaging Equipment Acquisition and Installation Procedure

Phase	Activity
Pre-Installation	<ul style="list-style-type: none"> • Initiate vendor discussions and collect equipment specifications, DICOM conformance statement and IMCIRW • Define and assemble project team to discuss equipment specs, evaluation needs, and vendor follow-up • Conduct site visit or clinical trial as needed • Project team creates a common report of findings and equipment evaluation (performance, connectivity, interface issues, or other system needs to fit existing environment)
Approval (as purchase order is issued)*	<ul style="list-style-type: none"> • Project team members order any specialty equipment needed • IS, PACS, and Imaging Equipment Services determine system support interaction needs • Project team develops the equipment integration test plan
Construction	<ul style="list-style-type: none"> • Project team participates in construction planning and room design meetings • Radiology manager, MITS, and RSC perform workflow analysis of proposed room design (workstation and network jack locations, optimal space, and patient flow for examinations, etc) • Radiology manager and RSC identify technologist training needs and follow-up with vendor to arrange applications training
Installation	<ul style="list-style-type: none"> • Imaging Equipment Services and MITS work with vendor on installation and verify equipment components with checklist procedure • Radiology manager and RSC collaborate on system training schedule and communicate with vendor to set training dates • Debugging of system is done by individual component support groups (IS, MITS, RSC, Equipment Services, etc) and problems are documented and communicated to vendor • Test images are created and sent through the digital imaging management and display components to ensure functionality and image quality on installed unit
Post-Installation	<ul style="list-style-type: none"> • Acceptance testing report is written by the project team • Project team members define ongoing system support roles

I. Vendor and Equipment Information

Please provide the name and contact information of vendor personnel responsible for insuring the accuracy of the information requested on this form, and who can help with questions pertaining to the provided information:

II. General Information

1. Sample DICOM images have been provided to Mayo on a writeable-CD. YES / NO
2. Is the modality compatible with a routed TCP/IP-based network environment? YES / NO
3. What upper level network protocols are supported? (circle all that apply)
Ethernet: Bandwidth = 10, 100, or 1000 Mbps Flat or Switched ATM FDDI Other: _____

III. Patient and Examination Data Entry

1. Does the modality support DICOM Modality Worklist service class to facilitate transfer of Patient Name, Patient ID Number, and Examination Accession Number from a Radiology Information System (RIS)? YES / NO
2. What pieces of information can be manually entered by the technologist in the modality user interface? (circle all that apply) Patient Name Patient ID Number Examination Accession Number

Can a bar code reader be used to "scan" the above information into the modality user interface (instead of typing into a keyboard)? YES / NO
3. Which fields can be used to filter a worklist query initiated by the modality? (circle all that apply) Examination date Modality Type Patient ID Exam Accession Number Others: _____
4. Can the modality worklist query/retrieve process be configured to occur automatically? YES / NO
If so, can the time period be configured? YES / NO

IV. Image Data Transmission

1. For radiographic and fluoroscopic modalities, are image and series numbers provided in the DICOM header?
Series number YES/NO If "YES", in which group and element? ____
Image number YES/NO If "YES", in which group and element? ____
2. Does the DICOM image object contain all information necessary for all image processing functions supported by modality/processing workstations provided by the modality vendor? YES / NO / Does Not Apply
3. Can images be sent to multiple DICOM Store destinations in a single step? YES / NO
3. Can DICOM store destinations that have been pre-configured on the modality be easily selected and deselected by the technologist?

V. Film Printing

1. Is film printing via the DICOM Basic Print service class available on the modality? YES / NO
2. Is film printing via direct digital connection with the printer (e.g. using the 3M952 protocol) available? YES / NO

VI. Other DICOM Services

1. Is DICOM Query / Retrieve supported by the modality as a service provider? YES / NO
What levels of query are supported (circle all that apply) Patient Study Series Image Others: _____
2. What data elements are provided by the modality when servicing queries? (circle all that apply)
Accession Number Study Instance UID Series Instance UID SOP Instance UID Number of images in each series

Fig 1. Imaging Modality Connectivity and Interoperability Requirements Worksheet (sample of questions).

workflow process was established. Table 2 is a summary of the procedural phases identified and the project team involvement in each phase.

RESULTS

Our message from the project team meetings and workflow discussions is *communication*. No one person has answers to all of the digital equipment installation questions at an operational level. It is important to have all of the system evaluation and installation experts on board from the very beginning (equipment request) through the installation phase. These experts make up the project team and ensure that relevant information is gathered in a timely manner and applied to the process.

The project team membership may vary with the type of digital acquisition equipment (modality) purchased, but the team and communication concept remains the same.

We have used the new process in two different projects this last year and feel that it is a great improvement over our previous experience. We learned that (1) lead time is needed to develop required interfaces; (2) the evaluation of workflow prior to remodeling or establishing workstation locations is important; and (3) there is a need for a designated point person or project manager to coordinate communication and vendor interactions. The team approach provides us with the tools for an efficient and successful process.